

Human Histology session

1<sup>st</sup> stage

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Histology of Renal system

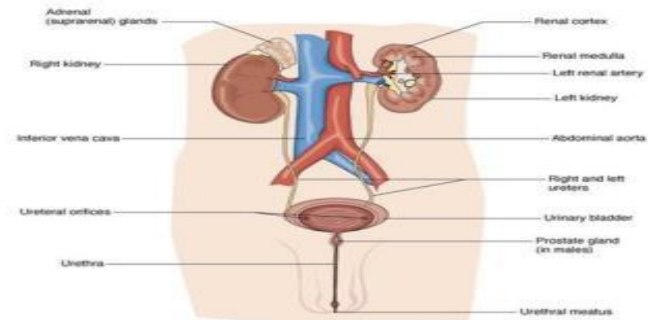
# Urinary system component

- \* Kidneys
- \* Ureters
- \* Bladder
- \* Urethra

# Function of urinary system

## Urinary System

- Functions of Urinary System:
- Excretion – removing nitrogenous wastes, certain salts and excess water from blood.
- Maintain acid-base balance
- Secrete waste products in the form of urine
- Eliminate urine from bladder



# Basic anatomy of kidney

- \* Renal Capsule – outer membrane that surrounds the kidney; it is thin but tough and fibrous
- \* Renal Pelvis – basin-like area that collects urine from the nephrons, it narrows into the upper end of the ureter
- \* Calyx – extension of the renal pelvis; they channel urine from the pyramids to the renal pelvis
- \* Cortex – the outer region of the kidney; extensions of the cortical tissue, contains about one million blood filtering nephrons
- \* Nephron – these are the filtration units in the kidneys

# Basic anatomy of kidney

- \* Medulla – inner region of the kidney contains 8-12 renal pyramids. The pyramids empty into the calyx.
- \* Medullary pyramids – formed by the collecting ducts, inner part of the kidney
- \* Ureter – collects filtrate and urine from renal pelvis and takes it to the bladder for urination
- \* Renal Artery – branches off of the aorta bringing waste-filled blood into the kidney for filtering in the nephrons; the renal artery is further subdivided into several branches inside the kidney. Each minute, the kidneys receive 20% of the blood pumped by the heart. Some arteries nourish the kidney cells themselves.
- \* Renal Vein – removes the filtered blood from the kidneys to the inferior vena cava

# Kidneys

- \* The kidneys are two reddish-brown bean-shaped organs found in vertebrates. They are located on the left and right in the retroperitoneal space, and in adult humans are about 12 centimetres (4+½ inches) in length. They receive blood from the paired renal arteries; blood exits into the paired renal veins. Each kidney is attached to a ureter, a tube that carries excreted urine to the bladder.

# Location of the kidneys

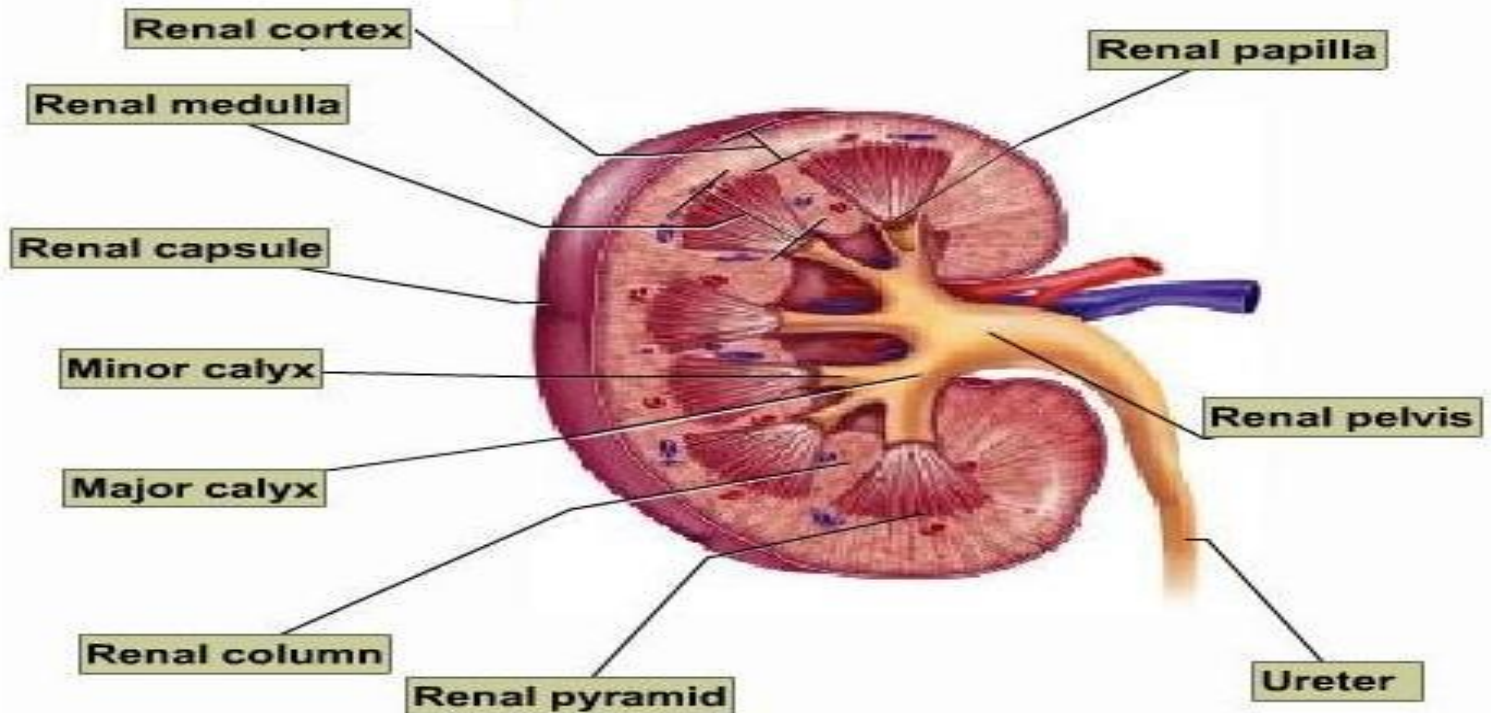
- \* The kidneys are situated below the diaphragm, one on either side of the spine. They are just below the rib cage. Each bears a small but crucial cap of endocrine tissue called the adrenal gland, which produce the important steroid hormones of the body.
- \* The right kidney is approximately one centimeter lower than the left.

# Kidney structure

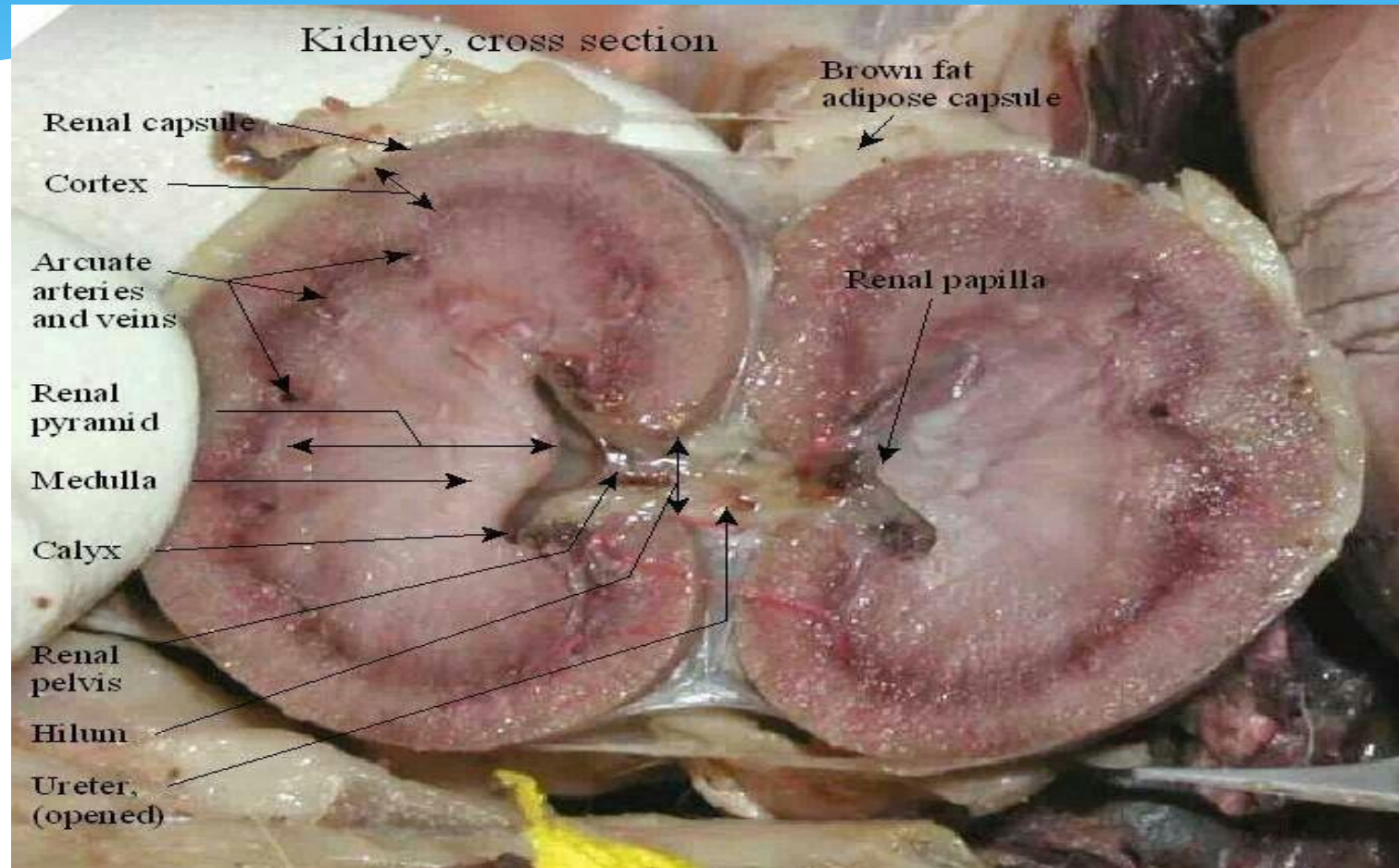
- \* the kidneys have a unique structure. The renal parenchyma can be divided into two main areas – the outer cortex and inner medulla. The cortex extends into the medulla, dividing it into triangular shapes – these are known as renal pyramids.
- \* The apex of a renal pyramid is called a renal papilla. Each renal papilla is associated with a structure known as the minor calyx, which collects urine from the pyramids. Several minor calices merge to form a major calyx. Urine passes through the major calices into the renal pelvis, a flattened and funnel-shaped structure. From the renal pelvis, urine drains into the ureter, which transports it to the bladder for storage.
- \* The medial margin of each kidney is marked by a deep fissure, known as the renal hilum. This acts as a gateway to the kidney – normally the renal vessels and ureter enter/exit the kidney via this structure.



# Macro structure of kidney



# Macro structure of kidney



# Histology of urinary system -Kidneys

The kidney contains about 1 million functional units called nephrons, which are continuous with a system of collecting tubules. The nephrons are responsible for filtration, excretion and reabsorption, and they regulate ion balance, water content, help to stabilize blood pressure.

The structure of nephron consist of the following parts:

1-renal corpuscle has 2 parts

A-Bowman's capsule

B-Glomerulus: which is a globular network of capillaries inside the capsule.

# Histology of urinary system -Kidneys

2-Proximal convoluted tubule

3-Loop of henle

4-Distal convoluted tubule

The collecting tubule, which eventually joins with other collecting tubules to form a collecting duct (the collecting duct is not considered part of nephron)

Note:

Filtrate contains everything found in blood plasma except proteins. As filtrate moves into collecting ducts , it has lost most of its water , ions and nutrients. The material that remains at this points is known as urine.

# Histology of urinary system -Kidneys

- \* There are 2 types of nephrons:

- \* Cortical nephron

80%-85% of nephrons are this type

- \* Juxtamedullary nephron

15%-20% of nephrons are this type

NOTE:

- \* Most of nephron in cortex layer

- \* Most of the loop of henle in medulla layer

# Histology of urinary system –Kidneys – nephrons-cross sections

Renal corpuscle(Bowman's capsule-Glomerulus)

The space between Bowman's capsule and glomerulus this space called urinary space.

Glomerulus: is described as (ball) of fenestrated capillaries.

Bowman's capsule: lines the urinary space and consist of :

1-An outermost layer-simple squamous epithelium.

2-An innermost layer-cells known as podocytes which adhere to the external surface of the glomerulus.

# Podocytes

- \* Podocytes are cells in the Bowman's capsule in the kidneys that wrap around capillaries of the glomerulus. Podocytes make up the epithelial lining of Bowman's capsule, the third layer through which filtration of blood takes place. The Bowman's capsule filters the blood, retaining large molecules such as proteins while smaller molecules such as water, salts, and sugars are filtered as the first step in the formation of urine.
- \* The podocytes have long foot processes called pedicels. The pedicels wrap around the capillaries and leave slits between them. Blood is filtered through these slits, each known as a filtration slit or slit pore.

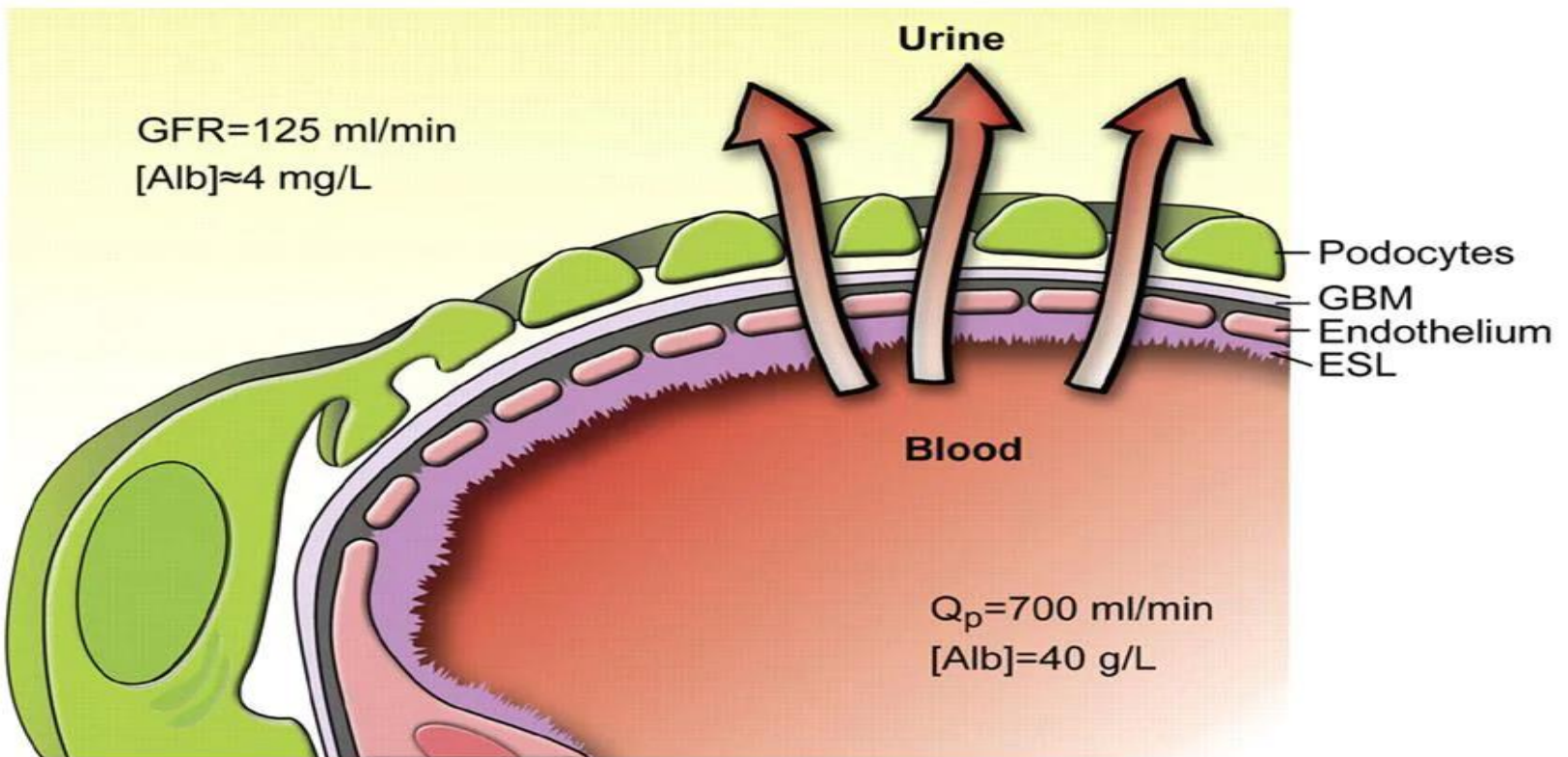
# Filtration system or barrier

- \* The glomerular capillaries are lined by a fenestrated endothelium that sits on the glomerular basement membrane, which in turn is covered by glomerular epithelium, or podocytes, which envelops the capillaries with cellular extensions called foot processes. In between the foot processes are the filtration slits. These three structures—the fenestrated endothelium, glomerular basement membrane, and glomerular epithelium—are the glomerular filtration barrier. A schematic drawing of the glomerular barrier is provided in the image below.

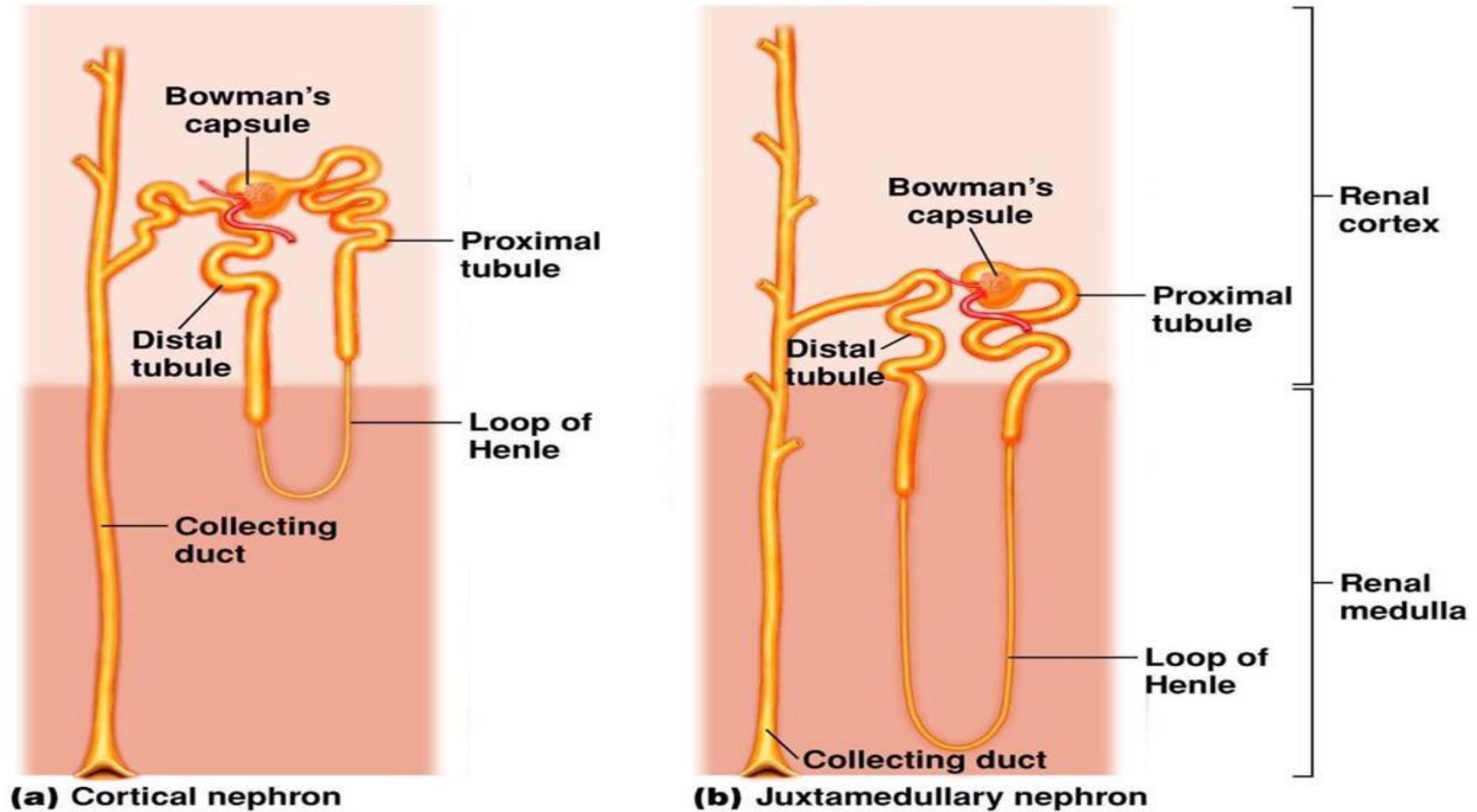
In addition to provide a physical barrier for cells and large proteins, the glomerular basement membrane and the pedicles of podocytes contain negatively charged glycosaminoglycans, which act to repel negatively charged proteins, particularly serum albumin.



# Filtration system or barrier



# Types of nephron



# Proximal convoluted tubule

the proximal convoluted tubule - which is the longest part of the renal tubule - has a simple tall cuboidal epithelium, with a brush border (microvilli). The epithelium almost fills the lumen, and the microvilli increases the surface area by 30-40 fold. The lumen of PCT tend not be clear (filled with debris)

Function:

The proximal tubule, in the cortex, reabsorbs most minerals and other nutrients from the tubular fluid and passes them to blood.

PCT is the site at which a majority (65%-67%) of recovered water, ions and glucose are transported from filtrate and added back to the blood.

# Distal convoluted tubule

The DCT is lined with simple cuboidal cells that are shorter than those of the [proximal convoluted tubule](#) (PCT). The lumen appears larger in DCT than the PCT lumen because the PCT has a brush border (microvilli) while no brush border in DCT.

Function:

- \* It regulates pH by absorbing bicarbonate and secreting protons ( $H^+$ ) into the filtrate, or by absorbing protons and secreting bicarbonate into the filtrate.
- \* Sodium and potassium levels are controlled by secreting  $K^+$  and absorbing  $Na^+$ . Sodium absorption by the distal tubule is mediated by the hormone aldosterone.

# Loop of Henle

In the kidney, the loop of Henle is the portion of a nephron that connects the proximal convoluted tubule with the distal convoluted tubule.

The loop of Henle can be divided into four parts:

- \* Thin descending limb of loop of Henle

The thin descending limb has low permeability to ions and urea while being highly permeable to water. The loop has a sharp bend in the renal medulla going from descending to ascending thin limb.

- \* Thin ascending limb of loop of Henle

The thin ascending limb is impermeable to water, but it is permeable to ions.

# Collecting duct system

The collecting duct system of the kidney consists of a series of tubules and ducts that physically connect nephrons to a minor calyx or directly to the renal pelvis. The collecting duct system is the last part of nephron and participates in electrolyte and fluid balance through reabsorption and excretion, processes regulated by the hormones aldosterone and vasopressin (antidiuretic hormone).

There are several components of the collecting duct system, including the connecting tubules, cortical collecting ducts, and medullary collecting ducts.

# Collecting duct system

- \* The collecting ducts span the renal cortex and medulla and concentrate the urine. The collecting duct is composed of simple cuboidal epithelium. There are two distinct cell types present in the collecting tubules: **intercalated cells** and **principal cells**.

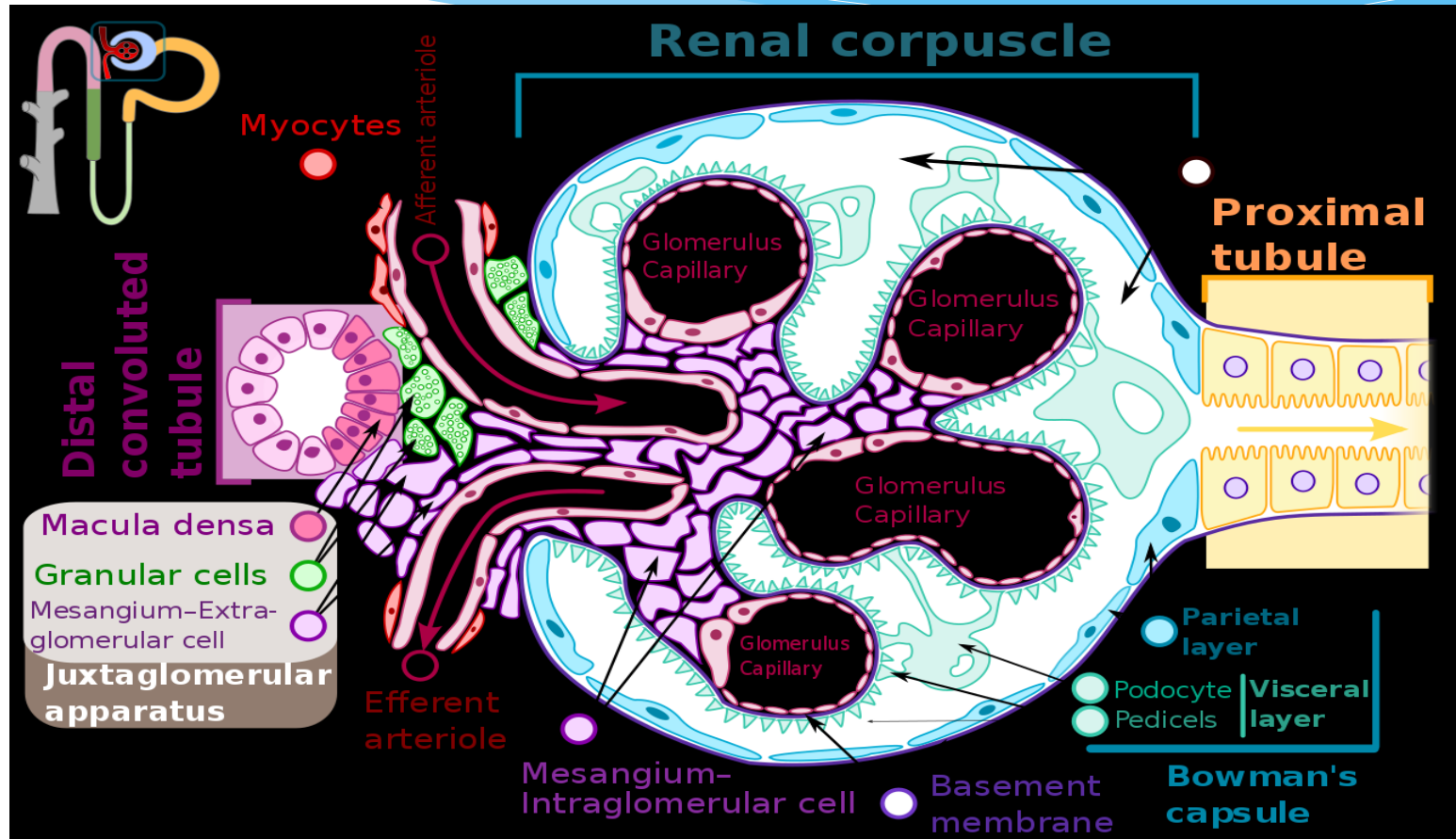
# Macula densa

- \* In the kidney, the macula densa is an area of closely packed specialized cells lining the wall of the distal tubule, at the point where the thick ascending limb of the Loop of Henle meets the distal convoluted tubule. The macula densa is the thickening where the distal tubule touches the glomerulus.
- \* The cells of the macula densa are sensitive to the concentration of sodium chloride in the distal convoluted tubule.



# Juxtaglomerular apparatus

- \* The juxtaglomerular apparatus (also known as the juxtaglomerular complex) is a structure in the kidney that regulates the function of each nephron, the functional units of the kidney.
- \* The juxtaglomerular apparatus consists of three types of cells:
  - \* the macula densa, a part of the distal convoluted tubule of the same nephron
  - \* juxtaglomerular cells, (also known as granular cells) which secrete renin which is regulate blood pressure.
  - \* extraglomerular mesangial cells



# Urinary Bladder

- \* The urinary bladder, or simply bladder, is a hollow muscular organ in humans and other vertebrates that stores urine from the kidneys before disposal by urination. In the human the bladder is a hollow distensible organ that sits on the pelvic floor. Urine enters the bladder via the ureters and exits via the urethra. The typical human bladder will hold between 300 and 500 ml before the urge to empty occurs, but can hold considerably more.

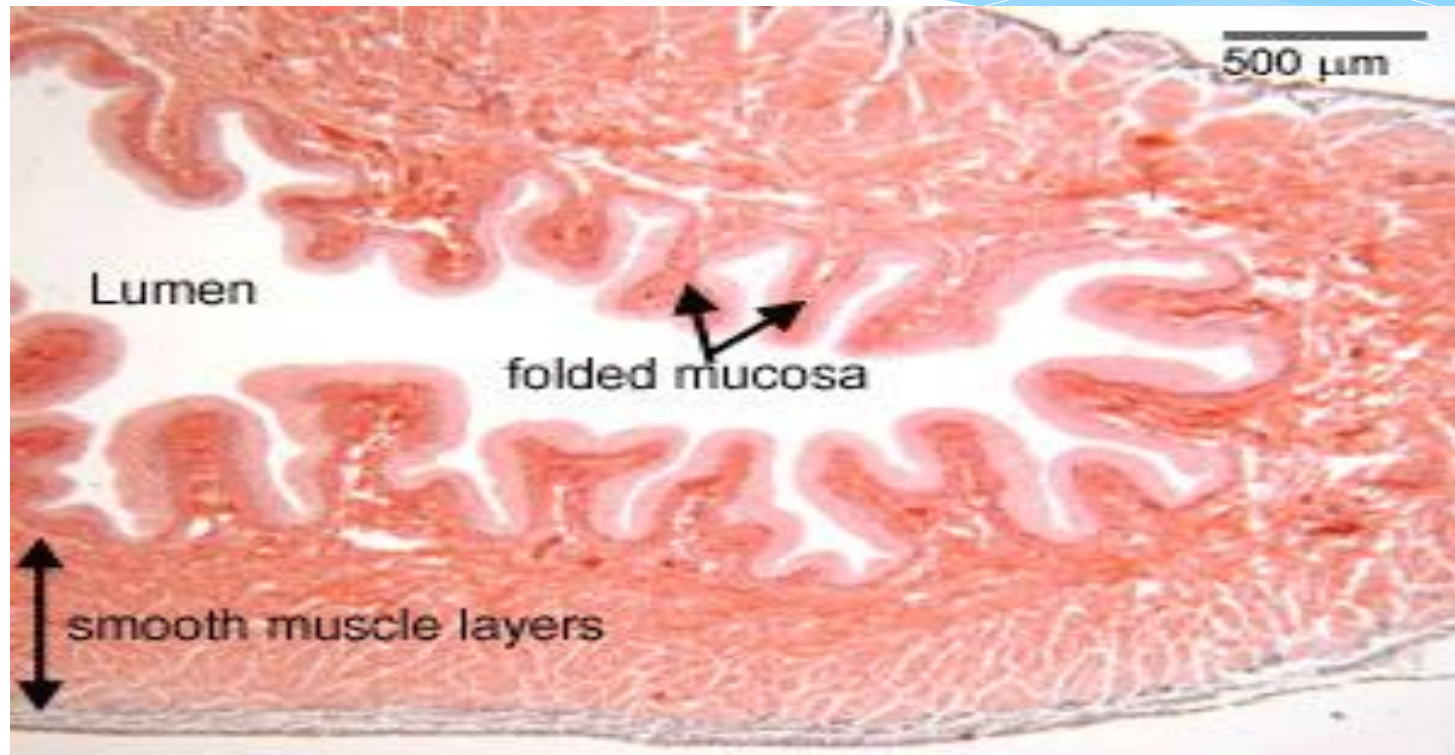
# Urinary Bladder

The bladder has three layers of smooth muscle, and a transitional epithelium and adventitia. It's harder to make out the three layers, because the bladder is sac like, not a tube.

The mucosa is heavily folded - this helps to accommodate for large volume changes.

The transitional epithelial lining can stretch until it looks like stratified squamous epithelium.

# Urinary Bladder



# Urethra

The urethra conveys urine from the bladder to the exterior of the body.

It is similar in structure to the ureter, though shorter.

The lumen is kept closed, unless urine is being passed.

The female urethra is lined by stratified columnar epithelium, with a few small mucosal glands that secrete mucus.

# End

- \* Thanks a lot for attention

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- \* 2021